

[Shutdown separators with improved properties]

Abstract

A microporous polyolefin battery separator membrane is extremely high in porosity, high in puncture strength, very low in shrinkage and with shutdown temperature of 130-140 degrees C and melt integrity greater than 165 degrees C. It is made of UHMWPE having a weight-average molecular weight of 1×10^6 or more and an inert filler. A second microporous polyolefin battery separator has a shutdown temperature of between 95 and 110 degrees C and a melt integrity of more than 165 degrees C. It is made from an UHMWPE having a weight-average molecular weight of 1×10^6 or more, a shutdown (LMWPE) having a weight-average molecular weight of 4500 or less and an inert filler. Both membranes have a thickness of 5-75 microns, a porosity of 30-95%, an air permeability of 1-200 sec/10cc , an average pore diameter of .001 to 1 micron and puncture strength of more than 300 grams/25 $\frac{1}{4}$ m.

TABLE 1

Examples									
Membrane Composition (parts by weight)	1	2	3	4	5	6	7	8	9
UHMWPE (M wt.= 1×10^6)	17	18	19	20	0	0	0	0	0
UHMWPE (M wt.= 3×10^6)	0	0	0	0	8	8	4	4	1
LMWPE (M wt.=1000)	0	0	0	0	10	9	5	4	0
TiO ₂	3	2	1	0	2	2	6	6	6
Thickness (μm)	25	25	25	25	25	25	25	25	25
Porosity (%)	74	68	55	51	52	52	51	59	64
Air permeability (Gurley-sec.)	2	2	2	2	27	16	15	13	8
Shutdown Temp. T _{SD} (°C)	138	138	138	138	100	105	138	145	>200
Melt Integrity (°C)	>200	>200	>200	>165	>200	>200	>200	>200	>200
Average pore diameter (μm)	<1	<1	<1	<1	<1	<1	<1	<1	<1
Puncture, 3mm pin (grams/25 μm)	726	771	863	1000	636	817	812	726	545